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(54) [TITLE OF THE INVENTION] LIQUID CRYSTAL DISPLAY DEVICE

(57) [ABSTRACT]

[PROBLEM TO BE SOLVED] To provide a liquid crystal display device which can accelerate the time required for liquid crystal injection in the liquid crystal injecting process in the manufacture of a large-screen TFT liquid crystal panel.

[SOLUTION] The liquid crystal to be sealed within the liquid crystal display panel is vacuum injected through injection ports 2 existing on one of the two sides parallel with the scanning wiring direction 3 and on the sealing 1 part enclosing the circumference of the screen having a rectangular shape. Then the liquid crystal is flown in the short side direction parallel with the signal wiring direction 4 on the screen.

[CLAIMS]

[CLAIM 1] A liquid crystal display device comprising a pair of substrates at least one thereof is transparent;

a liquid crystal composition layer having dielectric anisotropy and refraction anisotropy which is sandwiched between said substrates and aligned; polarizing means; plural pixels arranged in the form of matrix; pixel electrodes provided to each pixel; signal wiring electrodes; thin film transistor elements connected to scanning wiring electrodes, common electrodes; means for providing said thin film transistor elements with voltage signal waveforms for changing the light transmittance or reflectivity of the liquid crystal composition layer corresponding to said pixels; and a screen of a rectangular shape, wherein injection ports for vacuum injecting a liquid crystal composition between said substrates on one of the two sides parallel to the scanning wirings of the sealing part enclosing the circumference of the screen of the rectangular shape.

[CLAIM 2] The liquid crystal display device of claim 1 further comprising means for generating an electric field nearly parallel to substrate surfaces between the pixel electrodes and the common electrodes, wherein said liquid crystal composition is aligned without a twist or a deformation between said substrate when no electric field is applied to the liquid crystal composition, and the aligning direction of the liquid crystal director projected on the substrate surfaces is set to have an angle of not less than 60 degrees nor more than 90 degrees with the direction of the scanning wirings.

[CLAIM 3] The liquid crystal display device of claim 1, wherein the voltage signal waveforms to be applied to the scanning wirings are supplied from both of the two sides orthogonal to the scanning wirings.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD TO WHICH THE INVENTION BELONGS]

The present invention relates to a liquid crystal display device provided with a liquid crystal display panel having a large screen in which thin film transistors are used as switching elements for image display.

[0002]

[PRIOR ART] In recent years, active matrix liquid crystal displays with thin film transistors (TFTs) have been used in various fields such as camcorders or notebook personal computers, thereby forming a large market. These days, such displays have been expected to be applied to personal computers or monitors for workstations, increasing demands for 13- to 14-inch diagonal screens.

[0003] The mainstream of the display mode of TFT liquid crystal displays is a twisted nematic (TN) mode. For a large-screen display, expectations are placed on an in-plane switching (IPS) mode because of its extremely wide viewing angle properties. In this mode, an electric field parallel with the substrate surfaces is applied to move liquid crystal molecules parallel with the substrate surfaces as disclosed in Japanese Laid-Open Patent Publication No. 6-160878.

[0004] The screen of the TFT liquid crystal panel has an aspect ratio of 4:3, 16:9, or the like, and is generally longer in the horizontal direction. The array substrate provided with TFTs has scanning wirings extending horizontally for transmitting the selecting signals of the pixels, and signal wirings extending vertically for controlling the voltage levels of the pixels on the screen, thereby forming a matrix.

[0005] The TFT liquid crystal panel is generally manufactured as follows: the array substrate provided with TFTs and a counter substrate usually provided with a color filter are bonded to each

other with an appropriate space at the sealing part formed around the pixels. Later, liquid crystal is vacuum injected through the liquid crystal injection ports formed at the sealing part.

[0006] In the prior art, the liquid crystal injection ports are formed on the circumferential sealing part of the side orthogonal to the scanning wirings. This is because forming the injection ports on the side with a smaller width can provide a better space efficiency within the vacuum chamber used for injection.

[0007]

[PROBLEMS THE INVENTION IS GOING TO SOLVE] However, in the display panel of the aforementioned prior art liquid crystal display device, when injection ports are formed on the circumferential sealing part on the side orthogonal to the scanning wirings, liquid crystal is injected along the long side of the screen, that is, the region where the liquid crystal should be injected. Therefore, an increased screen size causes the problem that more time is required for injection.

[0008] In the prior art TN mode, in terms of the viewing angle properties, the main viewing angle direction of the panel is generally set at the top or the bottom direction, so the director direction of the liquid crystal at the central part between the upper and the lower substrate is nearly orthogonal to the injection direction of the liquid crystal, that is, the flow direction at the time of injection. This causes the problem that more time is required for injection due to the anisotropic viscous coefficient of the liquid crystal.

[0009] In the IPS mode expected for large-screen displays, a gap not larger than $4\mu\text{m}$, which is narrower than the prior art TN mode, is needed, which extremely increases the time for injection.

[0010] At the same time, increased screen size demands longer

scanning wirings, which causes a delay of a signal, and blunts the signal waveforms. Consequently, the voltages to be written in the pixel electrodes fluctuate, causing a difference in brightness between the region near the supplying side of the signals and the opposite side, which causes a brightness inclination between the right and the left of the screen. In addition, the compensation voltage for exempting the liquid crystal from a D.C. voltage differs within the screen, thereby causing display pattern burn or uneven display.

[0011] The present invention solves the aforementioned prior art problems, and provides a liquid crystal display device which can drastically shorten a liquid crystal injection time and improve the display grade of images.

[0012]

[MEANS TO SOLVE THE PROBLEMS] In order to solve the above-described problems, the liquid crystal display device of the present invention is characterized in that liquid crystal is injected along the short side of the screen, and at the time of injecting liquid crystal in the IPS mode panel, the flow direction and the direction of the liquid crystal director are almost aligned.

[0013] It is also characterized in that since scanning signals are supplied from both sides, their waveform blunting is suppressed so as to improve pattern burn or uneven display which result from uneven brightness between the right and the left of the screen or DC stress.

[0014] Thus, the liquid crystal injection time can be drastically accelerated, and the display grade of images can be improved because the voltage signals are supplied from both sides of the scanning wirings.

[0015]

[EMBODIMENTS OF THE INVENTION] The liquid crystal display device disclosed in claim 1 of the present invention is a liquid crystal display device comprising a pair of substrates at least one thereof is transparent; a liquid crystal composition layer having dielectric anisotropy and refraction anisotropy which is sandwiched between said substrates and aligned; polarizing means; plural pixels arranged in the form of matrix; pixel electrodes provided to each pixel; signal wiring electrodes; thin film transistor elements connected to scanning wiring electrodes, common electrodes; means for providing said thin film transistor elements with voltage signal waveforms for changing the light transmittance or reflectivity of the liquid crystal composition layer corresponding to said pixels; and a screen of a rectangular shape, wherein injection ports for vacuum injecting a liquid crystal composition between said substrates on one of the two sides parallel to the scanning wirings of the sealing part enclosing the circumference of the screen of the rectangular shape.

[0016] According to this structure, the liquid crystal is injected along the short side of the screen. The liquid crystal display device disclosed in claim 2 of the present invention is the liquid crystal display device of claim 1 further comprising means for generating an electric field nearly parallel to substrate surfaces between the pixel electrodes and the common electrodes, wherein said liquid crystal composition is aligned without a twist or a deformation between said substrate when no electric field is applied to the liquid crystal composition, and the aligning direction of the liquid crystal director projected on the substrate surfaces is set to have an angle of not less than 60 degrees nor more than 90 degrees with the direction of the scanning wirings.

[0017] According to this structure, at the time of injecting liquid

crystal in the IPS mode panel, the flow direction and the direction of the liquid crystal director are nearly aligned. The liquid crystal display device disclosed in claim 3 of the present invention is the liquid crystal display device of claim 1, wherein the voltage signal waveforms to be applied to the scanning wirings are supplied from both of the two sides orthogonal to the scanning wirings.

[0018] According to this structure, since scanning signals are supplied from both sides, their waveform blunting is suppressed so as to improve pattern burn or uneven display which result from uneven brightness between the right and the left of the screen or DC stress. In addition, neither one of the scanning wiring leading units needs the provision of injection ports.

[0019] The liquid crystal display devices showing the embodiments of the present invention will be described as follows with reference to the drawings.

(Embodiment 1)

A normally white TN-mode TFT liquid crystal panel having a 14-inch diagonal screen with an aspect ratio of 4:3 was manufactured. It has an XGA-compatible 768 by 1024 RGB resolution. Figure 1 shows the schematic view of this display panel having a seal shape.

[0020] As shown in Figure 1, the injection ports 2 were formed at two points of the sealing part 1 of one of the sides parallel with the scanning wiring direction 3. The width of the injection ports 2 is 15 mm. The rubbing direction of this panel is as shown in Figure 1, and the gap between the array substrate and the color filter substrate is 4.8 μ m. In the manufacturing process of this panel, the time required for the liquid crystal vacuum injection was about two hours, which was after the injection ports were soaked in the liquid crystal injection pool until the liquid crystal was completely

injected. The viscosity of the liquid crystal used was 23 centipoises and the refraction anisotropy index Δn was 0.090.

(Comparative Example 1) As Comparative Example 1 for the display panel in the liquid crystal display device of Embodiment 1, a display panel was produced as shown in Figure 2 in the same manner except that the injection ports 2 were formed on the sealing part 1 of the side orthogonal to the scanning wiring direction 3 as in the prior art, that is, of the side parallel to the direction 4 of the signal wirings 102 shown in Figure 5. As a result, the time required for the injection was about four hours.

[0021] In the display panel of the liquid crystal display device of Embodiment 1, the time required for the liquid crystal injection can be accelerated. One of the reasons the time required for the liquid crystal injection can be accelerated in the present invention is that the liquid crystal injecting direction, which used to be along the long side (scanning wiring direction 3) of the screen, is along the short side direction (signal wiring direction 4). The other reason is that the director direction of the liquid crystal molecules existing in the central part between the upper and the lower substrate is aligned to the flow direction at the liquid crystal injection time.

[0022] The viscosity of the liquid crystal is anisotropic, and the viscosity coefficient differs between when the flow direction is aligned to the director direction and when it is orthogonal to the director direction. In the former case, it corresponds to viscosity coefficient η_2 of Miesowicz, and in the latter case, it corresponds to η_3 . η_3/η_2 is usually about 1.4 to 1.9.

[0023] Therefore, the viscosity is lower when the flow direction is aligned to the director direction, and the time required for injection can be accelerated. It must be noted that the number, width, and shape of the injection ports of the display panel in the liquid crystal

display device of Embodiment 1 are one example to carry out the present invention, and the configuration of the present invention is not limited thereto.

(Embodiment 2) An IPS-mode TFT liquid crystal display panel having a 15.2-inch diagonal screen with an aspect ratio of 16:9, and 768 by 1364 RGB resolution. The array-shaped flat schematic view of the pixel unit of this display panel is shown in Figure 5.

[0024] As shown in Figure 5, in the pixel unit of this display panel, pixel electrodes 104 and counter electrodes 103 which are common electrodes are formed parallel with signal wirings 102, and thin film transistors 105 connected to the signal wirings 102, the pixel electrodes 104, and the scanning wirings 101 are driven by the signals supplied through the signal wirings 102 and the scanning wirings 101. Consequently, an electric field nearly parallel to the substrate surfaces is generated between the pixel electrodes 104 and the counter electrodes 103.

[0025] In general, in a large-screen liquid crystal display panel, the pixels are longer in vertical, so the pixel electrodes 104 and the counter electrodes 103 for an IPS mode had better be arranged to be extended in the direction of the signal wirings 102 as shown in Figure 5 so as to improve the open area ratio. The scanning wirings 101 and the signal wirings 102 are both made from aluminum.

[0026] The liquid crystal is aligned without a twist between the upper and the lower substrate while no electric field is being supplied. As shown in Figure 3 which indicates the schematic view of this display panel having a seal shape, the director direction 5 forms an angle of 80 degrees with the wiring direction 3 of the scanning wirings 101. Polarizer plates are so arranged that the polarizing axes of the upper and the lower substrate are

orthogonal to each other, and that one of the polarizing axes is set to be aligned to the director direction 5 of the liquid crystal.

[0027] As shown in Figure 3, the injection ports 2 were formed at two points of the sealing part 1 of one of the sides parallel with the scanning wiring direction 3. The injection ports 2 have a width of 20 mm. The gap between the array substrate and the color filter substrate of this panel is 3.2 μ m. In the manufacturing process of this panel, the time required for the liquid crystal vacuum injection was about two and half hours, which was after the injection ports were soaked in the liquid crystal injection pool until the liquid crystal was completely injected. The liquid crystal used was nematic liquid crystal having positive dielectric anisotropy (p type), and the viscosity and the refraction anisotropy index Δn thereof were 19 centipoises and 0.088, respectively.

[0028] On the other hand, n-type liquid crystal having negative dielectric anisotropy can be used with the IPS mode. However, it has the problem of too high a viscosity and of a low response rate, so p-type liquid crystal is superior in properties. In addition, in the case of the n-type liquid crystal, the director direction 5 of the liquid crystal while no electric field is being supplied must be set at 45 degrees or below with the scanning wiring direction 3. Therefore, the use of the n-type liquid crystal is not preferable because it leads to an increase in viscosity at the liquid crystal injection time, and to a decrease in the effect of shortening the injection time of the present invention.

(Comparative Example 2) As Comparative Example 2 for the display panel in the liquid crystal display device of Embodiment 2, a display panel was produced as shown in Figure 4 in the same manner except that the injection ports 2 were formed on the sealing part 1 of the side orthogonal to the scanning wiring direction 3 as

in the prior art, that is, of the side parallel to the direction 4 of the signal wirings 102 shown in Figure 5. As a result, the time required for the injection was about 6 hours and 20 minutes.

[0029] As shown in the display panel in the liquid crystal display device of Embodiment 2, the present invention exhibits great effects on the reduction of the liquid crystal injection time even in an IPS-mode TFT liquid crystal display panel. In the IPS mode, a gap as narrow as 4 μ m or less is needed in terms of panel transmittance and response time, so the effects of the injection time reduction by the present invention are extremely useful.

[0030] In the present invention, the angle formed by the direction 5 of the liquid crystal director and the direction 3 of the scanning wirings 101 is defined in the range of 0 to 90 degrees. In the IPS mode, when p-type liquid crystal is used, in terms of driving voltage and injection rate, the angle formed by the direction 5 of the liquid crystal director and the direction 3 of the scanning wirings 101 is preferably 60 degrees or larger.

(Embodiment 3) In the IPS-mode TFT liquid crystal display panel produced as the liquid crystal display device of Embodiment 2, driving ICs were mounted on both sides of the scanning wiring leading units so as to manufacture a liquid crystal display device in which voltage signals are supplied to the scanning wirings from both sides.

(Comparative Example 3) As Comparative Example 3 for the display panel in the liquid crystal display device of Embodiment 3, in the liquid crystal display panel produced in Comparative Example 2 for the display panel in the liquid crystal display device of Embodiment 2, a driving IC was mounted on the left side only so as to manufacture a liquid crystal display device in which voltage signals are supplied to the scanning wirings from one side.

[0031] In either case, the supply of voltage signals to the signal wirings was conducted only from the side on which no injection port was formed. The scanning voltage waveforms and the signal voltage waveforms are as shown in Patent Publication No. 8-272663.

[0032] When signals were supplied to the scanning wirings from one side, the difference in the optimal DC compensation voltage was 0.7 V between the left corner and the right corner of the screen. As shown in the display panel of the liquid crystal display device of Embodiment 3, when power is supplied from both sides of the scanning wiring leading units, the optimal compensation voltage was almost uniformed with little difference on the screen. When a fixed pattern was displayed for three hours and then the entire screen was changed to a halftone display, display burn was observed in Comparative Example 3, but was not in Embodiment 3.

[0033]

[EFFECTS OF THE PRESENT INVENTION] Thus, according to the invention of claim 1, liquid crystal can be injected along the short side of the screen.

[0034] Consequently, the time required for the injection operation in the liquid crystal injecting process can be accelerated. According to the invention of claim 2, at the time of injecting liquid crystal in an IPS mode panel, the flow direction can be nearly aligned to the direction of the liquid crystal director.

[0035] Consequently, the time required for the injection operation in the liquid crystal injecting process can be accelerated. According to the invention of claim 3, since scanning signals are supplied from both sides, their waveform blunting is suppressed so as to improve pattern burn or uneven display which result from uneven brightness between the right and the left of the screen or

DC stress. In addition, neither one of the scanning wiring leading units needs the provision of injection ports.

[0036] As a result, it becomes possible to prevent the wiring leading units from disturbing the liquid crystal injecting operation, to prevent the substrates from being broken or cut during the injecting operation, and also to suppress contamination of the mounted regions.

[0037] Thus, the liquid crystal injecting time can be greatly accelerated, which is particularly effective in an IPS mode demanding a narrow gap. This can be combined with supplying the voltage signals to the scanning wirings from both sides of the scanning wirings, so as to improve the display grade of images.

[BRIEF DESCRIPTION OF DRAWINGS]

[Figure 1] A flat schematic view of the display panel in the liquid crystal display device of Embodiment 1 of the present invention.

[Figure 2] A flat schematic view of the display panel of Comparative Example 1 for Embodiment 1 of the present invention.

[Figure 3] A flat schematic view of the display panel of the liquid crystal display device of Embodiment 2 of the present invention.

[Figure 4] A flat schematic view of the display panel of Comparative Example 2 for Embodiment 2 of the present invention.

[Figure 5] A schematic view of the panel pixel units of the liquid crystal display devices of Embodiments 2 and 3 of the present invention.

[Explanation of Symbols]

- 1 seal
- 2 injection ports
- 3 scanning wiring direction
- 4 signal wiring direction

- 5 director direction
- 101 scanning wirings
- 102 signal wirings
- 103 common electrode
- 104 pixel electrodes
- 105 thin film transistors (TFTs)

Figure 1

- 1 --- seal
- 2 --- injection ports
- 3 --- scanning wiring direction
- 4 --- signal wiring direction
- 上基板ラビング方向 --- upper substrate rubbing direction
- 下基板ラビング方向 --- lower substrate rubbing direction

Figure 2

- 上基板ラビング方向 --- upper substrate rubbing direction
- 下基板ラビング方向 --- lower substrate rubbing direction

Figure 5

- 蓄積容量 --- storage capacity



PATENT ABSTRACTS OF JAPAN

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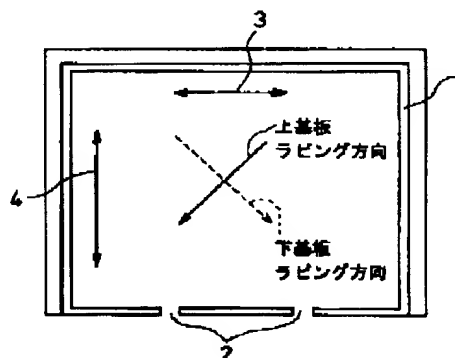
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G02F 1/1341(21) Application number: **09081769**(22) Date of filing: **01 . 04 . 97**(71) Applicant: **MATSUSHITA ELECTRIC IND CO LTD**(72) Inventor: **WAKEMOTO HIROBUMI**
TAKUBO YONEJI**(54) LIQUID CRYSTAL DISPLAY DEVICE****(57) Abstract:**

PROBLEM TO BE SOLVED: To make it possible to drastically shorten a liquid crystal injection time and to improve the display grade of images by forming injection ports for vacuum injection of a liquid crystal compsn. between substrates on one side of two sides parallel with the scanning wirings of a sealing part enclosing the circumference of a screen having a rectangular shape.

SOLUTION: The injection ports 2 for vacuum injection of the liquid crystal compsn. between the substrates are formed at two points on the one side of the two sides parallel with the scanning wiring direction 3 of the sealing 1 part enclosing the circumference of the screen having the rectangular shape. While the liquid crystal injection direction is heretofore in alignment to the long side direction (scanning wiring direction 3) of the screen, this direction is aligned to the short side direction (signal wiring direction 4) by adopting such constitution. In addition, the director direction of the liquid crystal molecules existing in the central part between the upper and lower substrate is aligned to the flow direction at the time of the liquid crystal injection, by which the viscosity is lowered. As a result, the time for the liquid crystal injection is

shortened and this constitution is effective at the time of an IPS(in-plane switching) mode.

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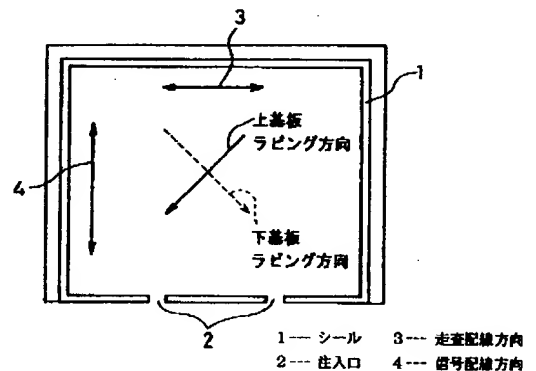
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(54) 【発明の名称】 液晶表示装置

(57) 【要約】

【課題】 大画面TFT液晶パネルの製造時の液晶注入工程で、その液晶注入のための所要時間を短縮化することができる液晶表示装置を提供する。

【解決手段】 液晶表示パネル内に封入される液晶が、矩形形状をした画面の周辺を囲むシール1部分で走査配線方向3に平行な2辺の内の一方の側に存在する注入口2を通じて真空注入され、画面において信号配線方向4に平行な短辺方向に沿って流入する。



【特許請求の範囲】

【請求項1】 少なくとも一方が透明な一对の基板と、該基板間に挟持され配向した誘電率異方性と屈折率異方性とを有する液晶組成物層と、偏光手段と、マトリクス状に配置された複数の画素と、その画素ごとに備えられ画素電極と、信号配線電極と、走査配線電極に接続された薄膜トランジスタ素子と、共通電極と、前記画素に対応する液晶組成物層の光透過率または反射率を変化させる電圧信号波形を前記薄膜トランジスタ素子に印加する手段とを有し、矩形形状の画面をもつ液晶表示装置において、前記基板間に液晶組成物を真空注入するための注入10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 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査信号の波形鈍りが抑制され、左右での輝度ムラやDCストレスが原因となるパターン焼き付きや表示ムラを改善することを特徴とする。

【0014】以上により、液晶注入時間を大幅に短縮することができるとともに、走査配線の両側からその電圧信号を供給するため、画像の表示品位を向上することができる。

【0015】

【発明の実施の形態】本発明の請求項1に記載の液晶表示装置は、少なくとも一方が透明な一対の基板と、該基板間に挟持され配向した誘電率異方性と屈折率異方性とを有する液晶組成物層と、偏光手段と、マトリクス状に配置された複数の画素と、その画素ごとに備えられ画素電極と、信号配線電極と、走査配線電極に接続された薄膜トランジスタ素子と、共通電極と、前記画素に対応する液晶組成物層の光透過率または反射率を変化させる電圧信号波形を前記薄膜トランジスタ素子に印加する手段とを有し、矩形形状の画面をもつ液晶表示装置において、前記基板間に液晶組成物を真空注入するための注入口を、前記矩形形状の画面の周囲を囲むシール部の走査配線に平行な2辺の内の一方の側に形成した構成とする。

【0016】この構成によると、液晶を画面の短辺に沿って注入する。請求項2に記載の液晶表示装置は、請求項1に記載の画素電極と共通電極との間に基板面に略平行な電界を発生させる手段を有し、液晶組成物への電界無印加時に、基板間で前記液晶組成物が捻れ変形をとまわずに配向しており、かつ基板面に投影した液晶ダイレクターの配向方向を走査配線の方向との角度が60度以上かつ90度以下となるようにした構成とする。

【0017】この構成によると、IPSモードのパネルにおける液晶注入時に、その流動方向と液晶ダイレクターの方位を略一致させる。請求項3に記載の液晶表示装置は、請求項1に記載の走査配線へ加えられる電圧信号波形を、走査配線と直交する2辺の両側から供給した構成とする。

【0018】この構成によると、走査信号を両側から給電するので走査信号の波形鈍りが抑制され、左右での輝度ムラやDCストレスが原因となるパターン焼き付きや表示ムラを改善するとともに、どちらの走査配線引き出し部にも注入口の設置を不要とする。

【0019】以下、本発明の実施の形態を示す液晶表示装置について、図面を参照しながら具体的に説明する。
(実施の形態1)画面の対角14インチ、アスペクト比4:3のノーマリーホワイトTNモードTFT液晶パネルを作製した。解像度はXGA対応で縦768×横1024RGBである。図1にこの表示パネルのシール形状の模式図を示す。

【0020】図1に示すとおり、注入口2は、走査配線方向3と平行な辺の一方のシール部分1の2箇所に設け

た。注入口2の幅は15mmである。このパネルのラビング方向は、図1に示すとおりであり、アレイ基板とカラーフィルタ基板の基板間ギャップは4.8μmである。このパネルの製造工程において、液晶を真空注入する際に要した時間は、注入口を液晶注入溜めに浸してから、液晶が完全に注入されるまで約2時間であった。なお、用いた液晶の粘度は23センチポアズ、屈折率異方性 Δn は0.090であった。

(比較例1)実施の形態1の液晶表示装置における表示パネルとの比較例1として、図2に示すように、注入口2を従来通り走査配線方向3と直交する辺、つまり図5の信号配線102の方向4と平行する辺のシール部1に設け、その他の構成を全く同様に形成した表示パネルの場合は、注入に要した時間は約4時間であった。

【0021】このように実施の形態1の液晶表示装置における表示パネルにおいては、液晶注入に要する時間の短縮が可能である。本発明において、液晶注入時間が短縮できる理由は、ひとつには、液晶注入方向が、従来は画面の長辺(走査配線方向3)に沿っていたのに対して、短辺方向(信号配線方向4)に沿っていることである。もう一つは、上下基板間の中央部に存在する液晶分子のダイレクター方向が、液晶注入時の流動方向と一致するためである。

【0022】液晶の粘度は異方性をもっており、流動方向がダイレクター方向と一致する場合の粘性係数と直交する場合の粘性係数が異なる。前者はMiesowiczの粘性係数 η_2 に相当し、後者は同じく η_3 に相当する。 η_3/η_2 は、通常1.4~1.9程度である。

【0023】したがって、流動方向がダイレクター方向と一致する場合の方が粘性が低く、注入に要する時間を短縮することができる。なお、本実施の形態1の液晶表示装置における表示パネルの注入口の数や幅、形状は、本発明を実施するための一例であり、本発明の構成を限定するものではない。

(実施の形態2)画面の対角15.2インチ、アスペクト比16:9、解像度が縦768×横1364RGBのIPSモードTFT液晶表示パネルを作製した。この表示パネルの画素部のアレイ形状の平面模式図を図5に示す。

【0024】この表示パネルの画素部は、図5に示すように、信号配線102に平行に画素電極104と共通電極となる対向電極103が形成されており、信号配線102と画素電極104および走査配線101に接続された薄膜トランジスタ105が、信号配線102および走査配線101を通じて印加される信号により駆動されることによって、画素電極104と対向電極103との間で基板面にはほぼ平行な電界が発生するようになっている。

【0025】一般に、大型の液晶表示パネルにおいては、画素は縦長の形状をしているため、IPSモードの

ための画素電極104および対向電極103の配置としては、それらの電極を、図5に示すように、信号配線102の方向に引き伸ばす方が、開口率上有利である。また、走査配線101、信号配線102は、いずれもアルミニウムで形成されている。

【0026】液晶は電界無印加時には上下基板間で捻れを持たずに配向しており、この表示パネルのシール形状の模式図を表す図3に示すように、そのダイレクター方向5は、図5の走査配線101の配線方向3と80度の角度を成している。また、偏光板は、基板の上下に互いの偏光軸を直交させ、かつ一方の偏光軸を液晶のダイレクター方向5と一致させて配置した。

【0027】また図3に示すとおり、注入口2は、走査配線方向3と平行な辺の一方のシール部分1の2箇所に設けた。注入口2の幅は20mmである。このパネルのアレイ基板とカラーフィルタ基板の基板間ギャップは3.2μmである。このパネルの製造工程において、液晶を真空注入する際に要した時間は、注入口2を液晶注入溜めに浸してから、液晶が完全に注入されるまで2時間30分であった。用いた液晶は、誘電率異方性が正(p型)のネマチック液晶であり、その粘度は19センチポアズ、屈折率異方性Δnは0.088であった。

【0028】一方、IPSモードには誘電率異方性が負のn型液晶も使用可能であるが、一般に粘度が高く、応答速度が遅いという問題があり、p型液晶の方が特性上優れている。また、n型液晶の場合は、電界無印加時の液晶のダイレクター方向5を走査配線方向3と45度以下に設定する必要がある。したがって、n型液晶の使用は、液晶注入時の粘性が増大する方向でもあり、本発明による注入時間短縮の効果が小さくなるため好ましくない。

【比較例2】実施の形態2の液晶表示装置における表示パネルとの比較例2として、図4に示すように、注入口2を、従来通り走査配線方向3と直交する辺、つまり図5の信号配線102の方向4と平行する辺のシール部1に設け、その他の構成を全く同様に形成した表示パネルの場合は、液晶注入に要した時間は6時間20分であった。

【0029】本実施の形態2の液晶表示装置における表示パネルに示すように、IPSモードTFT液晶表示パネルにおいても、本発明は、液晶注入時間の短縮に大きな効果を発揮する。とくに、IPSモードでは、パネル透過率と応答時間の点から4μm以下の狭ギャップが要求され、本発明による注入時間短縮の効果は非常に大きく有益である。

【0030】なお、本発明において、液晶ダイレクターの方向5と走査配線101の方向3との成す角は、0度から90度の範囲で定義している。IPSモードにおいては、p型液晶を用いる場合、駆動電圧と注入速度の観点から、液晶ダイレクターの方向5と走査配線101の

方向3との成す角度は60度以上が好ましい。

【実施の形態3】実施の形態2の液晶表示装置用として作製したIPSモードTFT液晶表示パネルに、駆動用ICを走査配線引き出し部の両側に実装し、走査配線への電圧信号供給を両側から行う液晶表示装置を作製した。

【比較例3】実施の形態3の液晶表示装置における表示パネルとの比較例3として、実施の形態2の液晶表示装置における表示パネルとの比較例2で作製した液晶表示パネルに、駆動用ICを左側のみに実装し、走査配線への信号供給を片側からのみから行う液晶表示装置を作製した。

【0031】いずれの場合も、信号配線への電圧信号供給は、注入口を設けていない側の辺のみから行った。走査電圧波形および信号電圧波形は特願平8-272663号に示すとおりである。

【0032】走査配線に片側のみから信号を供給した場合には、画面の左端と右端での最適DC補償電圧の差は0.7Vであったが、実施の形態3の液晶表示装置における表示パネルに示すように、走査配線引き出し部の両側から給電した場合には、画面内で最適補償電圧はほとんど差がなく一定であった。また、固定パターンを3時間表示した後、画面全面を中間調表示に切り換えてみたところ、比較例3においてはパターンの焼き付きが確認されたが、実施の形態3においてはパターンの焼き付きは認識されなかった。

【0033】

【発明の効果】以上のように請求項1の発明によれば、液晶を画面の短辺に沿って注入することができる。

【0034】そのため、液晶注入工程における注入作業の所要時間を短縮することができる。請求項2の発明によれば、IPSモードのパネルにおける液晶注入時に、その流動方向と液晶ダイレクターの方位を略一致させることができる。

【0035】そのため、液晶注入工程における注入作業の所要時間を短縮することができる。請求項3の発明によれば、走査信号を両側から給電するので走査信号の波形鈍りが抑制され、左右での輝度ムラやDCストレスが原因となるパターン焼き付きや表示ムラを改善するとともに、どちらの走査配線引き出し部にも注入口の設置を不要とすることができる。

【0036】そのため、配線引き出し部が液晶注入作業の障害となることを防止するとともに、注入作業中の基板の割れや欠けを防止でき、さらに、実装部の汚染も抑制することができる。

【0037】以上の結果、液晶注入時間を大幅に短縮することができ、とくに、狭ギャップが要求されるIPSモード時において有効であるとともに、走査配線への電圧信号供給を走査配線の両側から行うことと組み合わせ、画像の表示品位を向上することができる。

【図面の簡単な説明】

【図1】本発明の実施の形態1の液晶表示装置における表示パネルの平面模式図

【図2】同実施の形態1との比較例1の表示パネルの平面模式図

【図3】本発明の実施の形態2の液晶表示装置における表示パネルの平面模式図

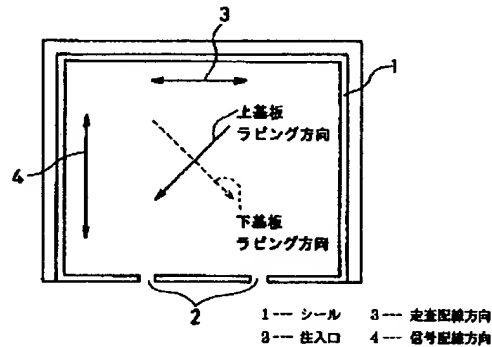
【図4】同実施の形態2との比較例2の表示パネルの平面模式図

【図5】本発明の実施の形態2および実施の形態3の液晶表示装置のパネル画素部の形状模式図

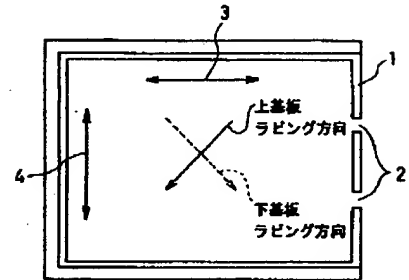
【符号の説明】

- 1 シール
- 2 注入口
- 3 走査配線方向
- 4 信号配線方向
- 5 ダイレクター方向
- 101 走査配線
- 102 信号配線
- 103 共通電極
- 104 画素電極
- 105 薄膜トランジスタ (TFT)

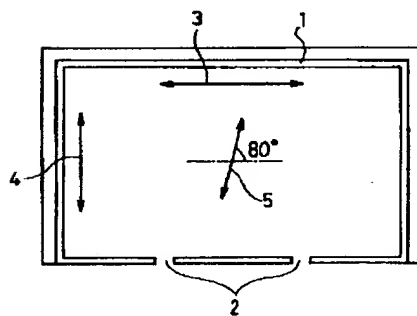
【図1】



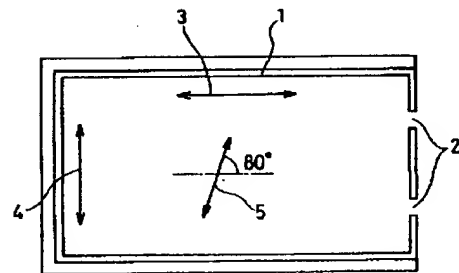
【図2】



【図3】



【図4】



【図5】

